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(54) TESTING ARTICLES FOR FLUID-TIGHTNESS

(71) We, LEYBOLD-HERAEUS VERWALTUNG GMBH, (sole personally responsible partner of LEYBOLD-HERAEUS GMBH & CO., Kommanditgesellschaft), a German Company of Bonner Strasse 504, 5, Koln-Bayental, Federal Republic of Germany, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method and apparatus for testing articles for fluid-tightness, and is generally applicable to the testing of, in particular but not exclusively, articles such as containers, sealed envelopes or packages and encapsulated or otherwise protected objects and closed systems.

In many areas of technology and industry objects or substances are kept in sealed containers to protect them from adverse effects by external gases or liquids. Examples are the protection afforded against atmospheric oxygen, against the ingress of microbes in the case of packed foods, or the protection against the penetration of moisture into sealed electrical components.

For testing the efficacy of the sealing of such containers for fluid-tightness diverse methods are used. One such method, which is frequently performed, consists in introducing a test gas into the article that is to be tested and in then checking whether any of the enclosed test gas is leaking out. The test gas may either be contained inside the article (for instance helium in Reed relays or fluochlorohydrocarbon in spray cans) or it may be introduced at a later time by exposing the completely sealed article for a prolonged period to a test gas suitably at a pressure above the internal pressure in the article. If the article has a leak the test gas will penetrate into its interior. The actual test for tightness is then carried out with a leak detector.

A detecting instrument often used to respond to a specific test gas is a leak detector containing a mass spectrometer adjusted to the test gas used. Usually the test gas is helium. In a leak test performed with such an instrument the article that is to be tested is introduced into a test chamber. With the aid of the vacuum pump which is usually incorporated on such a leak detector the test chamber is evacuated. The test then consists in checking whether any of the test gas leaks from within the article. In this procedure the test chamber must be evacuated to a very low pressure before the actual test takes place. If the article contains major leaks it is therefore possible for the entire test gas to be abstracted from the article by the evacuation of the test chamber to the pressure required for operating the mass spectrometer. Hence this procedure may be very well adapted for the detection of relatively small leaks but it may fail completely when there is a major leak. If the entire volume of test gas has been abstracted from the article during the evacuation of the test chamber the detecting instrument will be unable to differentiate between an article having a major leak and an article which is completely sound.

It is therefore an object of the present invention to provide a method of testing articles for fluid-tightness, which method does not involve a risk of articles exhibiting major leaks avoiding detection.

According to the invention the contemplated object is achieved by a method of testing an article for fluid-tightness, which comprises introducing into a test chamber the article which either contains a particular test gas or has been exposed to such test gas for a period of time sufficient to absorb gas through any leak in the article, testing the article for major leaks by connecting to the chamber through a snuffler pipe as herein defined a detector which responds specifically to the presence of the test gas, subsequently

performing a further test for the detection of minor leaks, and creating a vacuum in the test chamber at least prior to the further test.

A snuffler pipe is a pipe which incorporates a pressure stage which reduces a gas pressure at the entry end of the pipe that is substantially higher than can be employed for operation of a mass spectrometer leak detector — including atmospheric pressure — to a low pressure that is suitable for a mass spectrometer. The pressure stage usually consists of a very fine orifice at the entry end of the snuffler pipe. The snuffler pipe continuously draws in gas and conveys it to a detector which reacts specifically to the test gas. In other words, if test gas should be escaping from an article through a major leak whilst the pressure in the chamber is still atmospheric, then the resultant rise in the partial test gas pressure in the test chamber will be picked up by the snuffler pipe. The detector which reacts specifically to the test gas is preferably a mass spectrometer leak detector but may be any other leak detector, such as a halogen leak detector or the like.

The escape of the test gas through a major leak can be accelerated by expanding the gas in the test chamber before and/or during the performance of the leak test. This expansion causes the pressure in the environment of the article that is to be tested to drop sufficiently for the escape of gas through a leak not only to proceed by mere diffusion but also by convection. The expansion of the gas present in the test chamber has the advantage over evacuation of the test chamber by a vacuum pump that any test gas escaping through a major leak cannot be totally abstracted and lost through the pump.

Another advantageous step consists in agitating the gas in the test chamber before and/or during the performance of the major leak tightness test. This can be done for instance by the provision of a fan inside the test chamber. Agitation also ensures that any gas escaping through a major leak will be picked up by the snuffler pipe sooner.

The sensitivity of the proposed method in detecting major leaks is sufficient for many applications, particularly since the sensitivity can be increased by expanding the gas contained in the test chamber. Moreover, there is also the considerable advantage of the complete elimination of the risk of major leaks not being recognised.

The method of the invention also includes a further test for minor leaks after the principal test for major leaks with the snuffler pipe has been performed. This can be done for instance by evacuating the test chamber after the major leak test with the snuffler pipe has been completed and then connecting the chamber directly to a mass spectrometer leak detector. If this is done it is desirable to arrange matters so that the same detector can be used for both tests i.e. so that a single mass spectrometer leak detector can be used consecutively first for testing for major leaks (with the snuffler pipe) and then for minor leaks (by directly connecting the test chamber to the mass spectrometer leak detector). In this procedure the test for fluid-tightness with the snuffler pipe may be considered to be a preliminary rough test for major leaks which is then backed up by a highly sensitive test for minor leaks.

A suitable apparatus for performing the proposed method comprises a test chamber for receiving the article to be tested, which article either contains a particular test gas, or has been exposed to such test gas for a period of time sufficient for the article to absorb gas through any leak therein, a snuffler pipe as herein defined extending between the interior of the test chamber and a detector which responds specifically to the test gas employed for testing the article for major leaks, means for evacuating the test chamber, and means selectively operable for connecting the test chamber to the detector and by-passing the snuffler pipe for testing the article for minor leaks.

A preferred embodiment of test apparatus according to the invention, and examples of the manner of its performance, together with the above and other features and advantages of the invention will now be further described with reference to the accompanying drawing, the single Figure of which shows in highly schematic form one embodiment of test apparatus according to the invention.

In the drawing the test chamber is marked 1, the detecting instrument which specifically reacts to the test gas is marked 2, and the article which is to be tested for tightness is marked 3. The detector which responds specifically to the test gas is a mass spectrometer leak detector. It incorporates a vacuum pump 4 and a mass spectrometer 5 proper; these elements are schematically shown in a block 2 representing the leak detector.

The leak detector 2 is connected to the test chamber 1 through a valve 6 and a snuffler pipe 7 which preferably extends some distance into the test chamber 1. Tests for tightness in this embodiment are performed by first introducing the article 3 that is to be tested into the test chamber 1. The article 3 has previously been prepared for testing either by introducing a test gas into it or by exposing it to a test gas for a

sufficient period of time for the article to have absorbed test gas through any leak present. The snuffler pipe 7 is then taken into use by opening valve 6. If there is a major leak test gas will emerge by diffusion from the article 3 that is to be tested and this gas will pervade the whole of the testing chamber. After the lapse of a predetermined period of time it will be possible, by the response of the leak detector, to detect whether or not the article has a major leak.

The test chamber 1 is additionally connected by a pipe 9 incorporating a valve 10 to a container 11 which is itself connected by a pipe 12 incorporating a valve 13 to the vacuum pump 4 incorporated in the leak detector 2. The provision of the container 11 permits the escape of the test gas from the article 3 before or during the operation of the snuffler pipe 7 to be accelerated. For this purpose valve 10 is first closed and valve 13 is opened to permit the container 11 to be evacuated by the vacuum pump 4 to a predetermined vacuum pressure. The valve 13 is then reclosed and valve 10 opened. This simply results in the gas inside the test chamber expanding until it occupies the total volume provided by the combined capacities of the test chamber 1 and the container 11 without any gas being pumped out, so that the risk of a possible evacuation of the entire test gas that has leaked from the article 3 under test will be eliminated.

The test chamber 1 is further connected by a pipe 14 incorporating a valve 15 directly to the mass spectrometer leak detector 2. Furthermore, the test chamber 1 is fitted with a fan 16. The motor 17 for driving this fan 16 is mounted on the outside of a cover plate 18 which permits the test chamber 1 to be sealed so that it is vacuum-tight.

While testing the article 3 in the test chamber 1 for major leaks by the procedure already described the valve 15 is closed. The fan 16 which is provided inside the testing chamber 1 additionally permits the gas inside the test chamber to be well distributed so that any test gas escaping from the article 3 under test will very quickly become uniformly diffused throughout the chamber 1. The test gas will thus reach the intake of the snuffler pipe 7 more quickly and the time needed for performing the test of the article for major leaks by means of the snuffler pipe can thus be reduced. If the result of the test has been satisfactory i.e. if the article 3 has been found to have no major leak, valve 6 can be closed. Valve 15 is opened and the testing chamber is first of all evacuated to a pressure suitable for the mass spectrometer leakage detector (e.g. to about 10^{-4} mbar), this being done with the aid of the pump 4 incorporated in the leak detector 2. When the required pressure level has been established the test chamber is connected in a manner not specially shown to the mass spectrometer which is then used for detecting minor leaks in conventional manner in the course of the further test procedure.

The connection of the test chamber 1 to the leak detector 2 for carrying out the test for minor leaks may also be effected through pipe 9, valve 10 and container 11. In such a case a pipe 19 indicated by chain lines and valve 20 must be provided. Through this pipe 19 and the valve 20 also the preliminary evacuation of container 11 may be effected, so that in this modified embodiment the two pipes 12 and 14 and the valves 13 and 15 can be omitted.

Finally the test chamber is connected to a pipe 21 incorporating a valve 22. This connects the test chamber 1 to a container 23 for a gas containing no test gas whatsoever. More particularly, when the test gas is helium which is also present in the ambient atmosphere this feature proves useful. By allowing the gas from container 23, for instance nitrogen, which is free from test gas to enter the test chamber 1 whilst the article 3 is being exchanged for a further article to be tested, contamination by atmospheric helium of the test chamber and of the sealing rings, not shown, for tightly sealing the test chamber 1 is avoided.

The described embodiment is particularly suitable for the automatic leak examination of articles which are produced in large quantities. Appropriate control and regulating means must then be provided so that the entire procedures of the test can be performed automatically. Such control and regulating systems form no part of the present invention and they have not therefore been shown in the drawings. The apparatus particularly lends itself to a rapid serial execution of consecutive tests for major leaks if the required expansion is effected practically instantaneously by providing a valve 10 which is large in relation to valve 6. The apparatus also provides extremely high sensitivity (leakage rates up to 10^{-12} mbars/sec.).

WHAT WE CLAIM IS:—

1. A method of testing an article for fluid-tightness, which comprises introducing into a test chamber the article which either contains a particular test gas or has been exposed to such test gas for a period of time sufficient to absorb gas through any leak in the article, testing the article for major leaks by connecting to the chamber through a snuffler pipe as hereinbefore

defined a detector which responds specifically to the presence of the test gas, subsequently performing a further test for the detection of minor leaks, and creating a vacuum in the test chamber at least prior to the further test.

2. A method according to Claim 1, wherein prior to and/or during test for major leaks the gas in the test chamber is expanded.

3. A method according to Claim 1 or 2, wherein prior to and/or during the test for major leaks the gas inside the test chamber is agitated.

4. A method according to any one of Claims 1 to 3, wherein the further test is performed by a mass spectrometer leak detector.

5. A method according to Claim 4, wherein the mass spectrometer leak detector is used to perform both tests.

6. Apparatus for testing an article for fluid-tightness, comprises a test chamber for receiving the article to be tested, which article either contains a particular test gas, or has been exposed to such test gas for a period of time sufficient for the article to absorb gas through any leak therein, a snuffler pipe as hereinbefore defined extending between the interior of the test chamber and a detector which responds specifically to the test gas employed for testing the article for major leaks, means for evacuating the test chamber to the detector and by-passing the snuffler pipe for testing the article for minor leaks.

7. Apparatus according to Claim 6, wherein the detector is a mass spectrometer leak detector.

8. Apparatus according to Claim 6 or 7, further comprising an evacuable intermediate container and valve means for connecting the container to the test chamber.

9. Apparatus according to Claims 7 and 8, wherein the leak detector includes a vacuum pump connectable to evacuate the intermediate container.

10. Apparatus according to Claim 7, wherein the selectively operable means comprises a pipe incorporating a valve for connecting the test chamber directly to the mass spectrometer leak detector.

11. Apparatus according to Claim 7, wherein the selectively operable means comprises a pipe incorporating a valve for connecting the intermediate container directly to the mass spectrometer leak detector.

12. Apparatus according to any one of Claims 6 to 11, further comprising means for introducing a gas which is free from the test gas into the test chamber.

13. Apparatus according to any one of Claims 6 to 12, including a fan inside the test chamber.

14. A method of testing an article for fluid-tightness according to Claim 1 and substantially as hereinbefore described.

15. Apparatus for testing an article for fluid-tightness, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawing.

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1519499 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale